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“Monitoring of Regional Resources Using Remotely Sensed Images for Drought Assessment”

Ph.D. Work plan

Submitted to

Swami Ramanand Teerth Marathwada University, Nanded

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Monitoring of Regional Resources Using Remotely Sensed Images for Drought Assessment

1. A Brief Resume of the Proposed Problem:

The applications of the satellite imagery are spread over many applications in routine life like orthoimage, agricultural development, 3D GIS and special applications like disaster forecasting and monitoring, checking for mineral potential, military surveillance etc. Land use and land cover mapping and the applications allied with it can be handled with the help of satellite imagery effectively. Studies like disaster and climate change are also getting benefitted from a wide range of remote sensing observations. Disaster forecasting and monitoring is one of the challenges of the today's world. Disasters can be of various types and their intensity, frequency varies differently. Disasters can be a flood, a cyclone, agricultural drought, landslides, earthquakes and forest fires etc. Disasters are proven to be very destructive in nature. Forecasting and monitoring disaster is need of time, which can prevent harm to the world. Drought is one of the major types of disaster. [5]

Droughts are very different from the more attention-grabbing hazards such as tsunamis and earthquakes in a variety of significant ways. Of all-natural disasters, drought affects the largest number of people. 68% of India is vulnerable to drought. Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. Drought refers to water scarcity concerning given demand in a specific region. Drought can have economic, environmental, and social impacts. [17]

The regional study is focused on the special terrain and can play an important role in deciding the regional policies. The proposed study will be helpful to answer several socio-economic problems associated with drought in the region. The region under study is one of the most drought-prone regions of Maharashtra state like Marathwada.

This work will be useful for the wide group of stakeholders along with the government to keep a track of the disaster like drought and can practice a early warning center to forecast and monitor it.

2. Introduction:

Satellite imagery is widely used for different applications now a days such as for identification of different objects, defence, disaster management, development and planning, study forestry and environment etc. Remote means far away and sensing means observing or acquiring some information. Remote sensing means acquiring information about things from a distance, also known as Earth Observation. Receiving this energy for interpretation is called sensing. Satellite image analysis is widely used all over the world and satellites for typical applications like communication satellites, weather satellites, navigation satellites and earth observation satellites have been launched by various countries. Optical imagery and Synthetic Aperture Radar (SAR) imagery is available from the satellites. These imageries are in use according to the demand of the application. [17]

3. Review of Literature and Development:

3.1 Drought Monitoring:

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. Drought refers to water scarcity concerning given demand in a specific region. Drought can have economic, environmental, and social impacts. Droughts are very different from the more attention-grabbing hazards such as tsunamis and earthquakes in a variety of significant ways. Of all-natural disasters, drought affects the largest number of people. 68% of India is vulnerable to drought. As per the "National Commission on Agriculture" droughts can be classified into three types:

1. Meteorological
2. Agricultural
3. Hydrological

And the type of drought and its severity can also be monitored, by analyzing the different indices used for measurement of drought. [17]

It is very interesting to understand that, several indices /indicators need to be defined to measure drought conditions, of a specific type. Universally accepted drought indicator, to characterize drought condition does not exist. Several indicators do exist and applied as per the methodology adopted.

3.2 Key Impacts of Drought on Globe:

Droughts develop gradually; they are referred to as slow-onset natural hazards. Droughts often do not get any global attention until they trigger a famine or cause wildfires. Unfortunately, response to droughts is too often reactive in terms of crisis management. According to WMO droughts are by far the most damaging of all natural disasters because of their long-term socio-economic impacts. Early detection of droughts is important for managing emerging crop losses to prevent or mitigate possible related famines, and for dealing with increased fire risk. Satellite imagery helps to monitor precipitation, soil moisture, and vegetation health to support drought early warning systems.

Following could be the most important impacts of drought on globe:

1. Environmental Impacts:
   Drought can bargain a wide scope of environment administrations, including provisioning administrations like food, fuel, and freshwater. Drought can modify biological system capacities and bargain environment concerns, bringing about decreased or harmed natural working.
2. Economic Impacts:
   Drought may bring about critical, long haul financial misfortunes in a scope of areas. Misfortunes might be neighbourhood to the dry spell influenced zone or they might be far and wide through monetary worth chains and by falling misfortunes to different areas and the public or worldwide economy. Food deficiencies and food uncertainty, joblessness, destitution, swelling, strife, and inward dislodging or relocation are a portion of the effects.

3. Health impacts:
   Drought can cause significant human health impacts, and the socioeconomic environment in which drought occurs influences the resilience of affected populations. Drought impacts on food production systems and agricultural value chains can contribute to nutritional deficiencies.

3.3 Drought Monitoring Principles:

There is classified into three important types. Each drought type can be characterized with the help various indicators. The main difficulty of the drought prediction is that there is no universal indicator available which can predict drought. Five practical issues become important in any analysis of drought. These include: 1) time scale, 2) probability, 3) precipitation deficit, 4) application of the definition to precipitation and to the five water supply variables, and 5) the relationship of the definition to the impacts of drought. [5]

Following is the list of commonly used drought indicators:

1. Standardized Precipitation Index (SPI)
2. Aridity Index (AI)
3. Percent of Normal Precipitation
4. Palmer Drought Severity Index (PDSI)
5. Rainfall Anomaly Index (RAI)
6. Standardized Precipitation Evapotranspiration Index (SPEI)
7. Normalized Difference Vegetation Index (NDVI)
8. Vegetation Condition Index (VCI)
9. Vegetation Health Index (VHI)
10. Soil Adjusted Vegetation Index (SAVI) etc. [1]

3.4 Latest Trends in Drought Monitoring:

With the change in the technology and advent tools available, drought monitoring is also changed. Through research papers the concept of using machine learning is proposed. Yaokui Cui has proposed an idea to obtain long time and spatio temporal continuous soil moisture over the Tibetan plateau. Downscaling Solar-Induced Chlorophyll Fluorescence Based on Convolutional Neural Network Method to Monitor Agricultural Drought by Zhaoxu Zhang. [2] John Nay has discussed A machine-learning approach to forecasting remotely sensed vegetation health. Pouya Aghelpour proposed A Theoretical Approach for Forecasting Different Types of Drought Simultaneously, Using Entropy Theory and Machine-Learning Methods. [6]

Other than machine learning the latest approaches in the drought monitoring are data mining, Particle filter approach, use of Copulas, IoT, Python etc. Researchers used single drought indicator as well as combined drought indicators. Use of soil moisture and crop yield for yield analysis and drought monitoring is also possible.

4. Objectives of Proposed Research:

Work objectives are set for monitoring regional study:

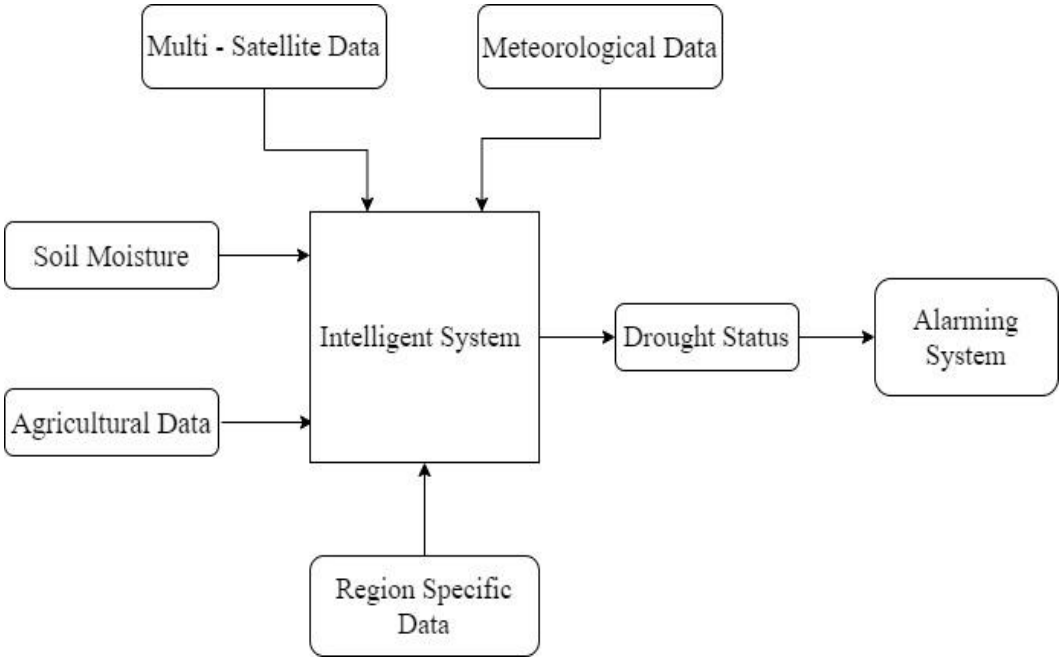
1. Literature review for understanding the need of drought forecasting and monitoring.
2. Discrimination between different types of droughts.
3. Identification of the various indicators used and available for the regional drought estimation.
4. Classification of drought indicators according to type of drought.
5. Assimilation of different indices, soil moisture, satellite imagery, soil properties and topography etc. for drought analysis.
6. Compare different strategies in machine learning for efficient drought measurement.
7. Recommend an optimum or best suitable model for drought estimation.
8. Accuracy enhancement in near real time drought estimation using ANN
9. To provide early warning systems for the stakeholders.

5. Methodology to be used and adopted:

After a detailed survey, it has been noted that the method to measure and monitor drought varies with different conditions, applications, and regions. Different countries try to monitor drought in near real-time as per the application and the indicators most suited to the local terrain conditions. Regional study is focussed on the special terrain and plays an important role in deciding regional policies. Literature on drought studies revels that the use of single indicator for the analysis of drought is not efficient. Instead researchers have preferred to combine more than one indicator and assimilate it to drought analysis. [1]

The study area selected for this study is Marathwada region and is the most drought prone area of the Maharashtra state. Marathwada region comes under tropical semi-arid zone. Frequent drought is experienced by this region compared to rest of the Maharashtra state. Comparatively a very small research has been carried out on the drought and its impacts on the region. More recently S. Swain discussed use of SPI, EDI and PNPI using MSWEP Precipitation over Marathwada. [4] Sneha S. Kulkarni proposed Developing a Remote Sensing-Based Combined Drought Indicator Approach for Agricultural Drought Monitoring over Marathwada, India. [8]

The proposed method will be helpful in this manner to answer many socioeconomic problems through this technical study in the most drought-prone regions of Maharashtra state like Marathwada. The study proposes use of combined drought indicators along with yield data and soil moisture for the effective drought analysis. [8] Artificial Neural Network helps to enhance the efficiency and improve the time required. Neural networks can be introduced to monitor near real time drought. [16] Various input parameters/index can be used for training like SPI, VCI, SPEI, NDVI, and model can be trained to have drought/ drought severity as an output. A comparison between models will be helpful in finding out the best suitable model for the conditions.



Block Diagram: The typical diagram for the proposed approach is as shown in fig.

6. Importance of study:

6.1. International status:

With the advent of new technologies, different countries have launched different satellites. Few of them are dedicated to the climate and drought monitoring. The imagery getting available is also improving in terms of receptivity, type, resolution etc.

The Global Drought Information System (GDIS) is one of such international effort to pull together the best non-prescriptive drought information from local providers and provide an "apples to apples" comparison of drought conditions around the world. The Global Information and Early Warning System on Food and Agriculture (GIEWS) seeks to strengthen agricultural drought monitoring and early warning globally.The MapViewer of the Global Drought Observatory (GDO), hosted by the European Commission, generates global maps of monthly precipitation, mean annual precipitation, SPI, soil moisture anomaly, and NASA Gravity Recovery and Climate Experiment (GRACE) Total Water Storage anomaly.

A variety of studies have been conducted to evaluate the suitability of drought indices for different applications. Guttman compared the PDSI and SPI and reported that the PDSI varied from site to site throughout the US with complex structure and long memory, while the SPI did not vary from site to site and was an easily interpreted, simple moving average process.

6.2. National Status:

Many studies have been carried out to forecast, monitor and mitigate drought on Indian scenario. As part of Disaster Management Support Programme (DMSP), Decision Support Centre is established at NRSC for monitoring natural disasters viz. flood, cyclone, agricultural drought, landslides, earthquakes and forest fires in near real-time using space and aerial remote sensing based inputs.

National Agricultural Drought Assessment and Monitoring System (NADAMS), provides near real-time information on prevalence, severity level and persistence of agricultural drought at state/ district/sub-district level. It covers 14 states of India, which are predominantly agriculture based and prone to drought situation. Agricultural conditions are monitored at state/district level using daily NOAA AVHRR data for 9 states. AWiFS (Advanced Wide Field Sensor) of Resourcesat (56 m resolution) is used for detailed assessment of agricultural drought at district and sub district level in five states. [19]

7. Proposed Work Plan:

Chapter 1: Introduction
Chapter 2: Literature Review
Chapter 3: Pre-processing of the satellite images
Chapter 4: Extracting the data in the form of indices associated with drought
Chapter 5: Methodology of the work
Chapter 6: Preparation of drought model
Chapter 7: Analysis of the drought using machine learning approach
Chapter 8: Drought estimation
Chapter 9: Results, Conclusion and Future scope

8. Year wise Plan of work and target to be achieved:

Sr. No.	Year 1	Year 2	Year 3
1	Literature Survey of Remote sensing and its applications and study of different applications of satellite Remote sensing	Study and development of integral approach method by assimilating different drought indices.	Study and Investigation of machine learning approach to predict the near real time drought status.
2	Study of various types of satellite images available according to application. Understanding various tools to read and process the satellite images.	Design and Investigation of drought monitoring system for the region under study with the applicable parameters along with drought indices like soil moisture, topography etc.	Comparative study, identification of the best suitable satellite indices for analysis, accuracy, robustness and efficacy of proposed strategies.
3	Acquiring the satellite data required for the Implementation of drought monitoring in the literature using ArcGIS, SNAP etc.	Experimentation and real time implementation of near real time drought monitoring system.	Preparation of Report

9. Expected outcome

1. To tackle the problem of drought at the regional level and to propose a unified and unique efficient drought measuring strategy.
2. Assimilation of different indices, soil moisture, satellite imagery, soil properties and topography to predict drought status.
3. Accuracy enhancement in near real time drought estimation.
4. Application of machine learning to increase the efficient and fast detection of drought by dealing with the complex variables associated with it.

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